

Equation of state constraints for the cold dense matter inside neutron stars using the cooling tail method

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Abstract

© ESO, 2016. The cooling phase of thermonuclear (type-I) X-ray bursts can be used to constrain neutron star (NS) compactness by comparing the observed cooling tracks of bursts to accurate theoretical atmosphere model calculations. By applying the so-called cooling tail method, where the information from the whole cooling track is used, we constrain the mass, radius, and distance for three different NSs in low-mass X-ray binaries 4U 1702-429, 4U 1724-307, and SAX J1810.8-260. Care is taken to use only the hard state bursts where it is thought that the NS surface alone is emitting. We then use a Markov chain Monte Carlo algorithm within a Bayesian framework to obtain a parameterized equation of state (EoS) of cold dense matter from our initial mass and radius constraints. This allows us to set limits on various nuclear parameters and to constrain an empirical pressure-density relationship for the dense matter. Our predicted EoS results in NS a radius between 10.5-12.8 km (95% confidence limits) for a mass of 1.4 M, depending slightly on the assumed composition. Because of systematic errors and uncertainty in the composition, these results should be interpreted as lower limits for the radius.

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Keywords

Dense matter, Stars: neutron, X-rays: binaries, X-rays: bursts